Characteristics and Use of Separated Manure Solids (following composting) For Dairy Freestall Bedding, and Effects on Animal Health and Performance in an Iowa Dairy Herd

A.S. Leaflet R2322

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Summary and Implications

This summary provides data regarding characteristics (dry matter content and environmental mastitis pathogen counts) of separated manure solids following composting and usage on mattresses (North free stall barn) and deep bedded compost freestalls (2 South freestall barns) in an Iowa dairy herd. Dry matter content of fresh separated solids was 20-25%, with composted solids being 20-40% when stored outside (variable due to weather) and 30-50% when stored in a hoop building. Dry matter content of separated solids once in stalls increased to 60-80%. Composting resulted in coliform bacteria levels < 10^2 (detection levels) but levels of all bacteria were elevated to baseline stall values following < 12 hr. time in stalls. Cow comfort, cleanliness, and feet and leg health were excellent on the bedded manure solids. SCC remained constant or declined following use of separated with no associated increases in clinical mastitis. Two clinical mastitis outbreaks were seen during the trial but not correlated to bedding bacterial counts. The first outbreak was associated with coliform counts in bulk tank milk > 200 CFU indicating weakness in milking management and teat end cleanliness prior to unit attachment. The second outbreak coincided with a nutritional management problem and a mild acidosis situation. This data shows that composted manure solids can provide a comfortable, effective bedding source if a consistent product is generated and managed properly, and stall, alley, and milking management areas are optimized.

Introduction

Bedding materials are used in most types of housing for dairy and other animals and are generally required to improve animal comfort and cleanliness, and assist in removal of moisture from the stall / housing environment. The choice of bedding materials by farms is related to the manure system used, availability and cost of materials, and personal preference with a desire to optimize or maximize the above requirements. Technology to separate solid material from the liquid portion of cow manure and the use of this material as animal bedding has been known for > 30 years. There is a resurgence of interest in using manure solids that is growing from an increase in the installation of methane digesters, and regulations involving manure storage and application. Also scarcity and high price of certain organic beddings (sawdust) has also increased interests.

Study objectives were to evaluate the characteristics of separated manure solids, following the material through composting and usage in stalls, impact on herd performance, and provide insight into proper conditions and management techniques necessary to make this technology successful.

Materials and Methods

Study participant:

This central Iowa dairy has 1700 milking cows housed in 3 lactating cow free stall barns (1000 cow North barn with mattresses, and 2 – 350 cow deep bedded compost freestall barns). In early March 2006, the dairy put in a screen solid separator (Ag Pro) and separated solids were placed in long compost piles or rows and allowed to heat and compost for 2 weeks (turned every few days). Composted solids were either stored in these piles outside until used in stalls or transported and stored in a hoop building. New bedding materials were added to stalls every 2-3 days, and stalls were groomed and maintained during every milking. Deep compost stalls were tilled or turned every milking using a tillage apparatus attached to a tractor. Data was collected from May-July 2006 (bulk tank bacterial data Mar. - July).

Sample collection:

Samples were initially collected on a biweekly basis. Samples included 1) raw manure from alleys in all barns; 2) fresh screened separated manure solids (right off separator; 3) composted manure solids stored outside; and 4) composted manure solids stored in a hoop barn. Samples from deep bedded freestalls were obtained daily during the week (Mon-Fri) (more random in mattress barn) from compiling grab samples from 5% of stalls within a pen or barn. Samples were frozen and transported to ISU.

Bulk tank milk samples were also taken for bacterial analysis and both creamery and DHI data was available.

Dry matter content:

25 grams of each sample was placed in 5 individual aluminum trays. Trays were placed in a drying oven for 24 hours, reweighed, and dry matter content was calculated.

Environmental mastitis organism counts:

10 grams of sample material were added to 90 ml of phosphate buffered saline and mixed thoroughly. Samples were then serially diluted with 6 dilutions (10^{-2} – 10^{-6}) plated on MacConkey agar (total gram negatives and coliforms) and Trypticase soy blood agar (total bacteria and alpha streptococci). Plates were read at 24 and 48 hours.

Results and Discussion

Pooled bulk tank milk culture results are shown in Table 1. The herd had no Strep. agalactiae and some Staph. aureus (contagious). Most weeks, coli counts were < 100 showing excellent drying of teats. However, coli were elevated a few weeks including the week of 5/29 (13,900) indicating improper drying of teats at milking (or excess water use). During this week, the dairy experienced a 10X increase in clinical mastitis, although bedding bacteria counts were similar across weeks. Environmental streps were the predominant organism in bulk milk cultures (bedding and skin inhabitants). Most weeks, counts were < 400 indicating good teat and udder preparation, but some weeks (> 1000) indicate milking prep issues.

Dry matter content of raw manure, fresh separated manure solids, and composted solids (stored outside and inside) averaged 8-9%, 20-25%, 22-38, and 35-50%, respectively (Figure 1). Composted solids stored outside had lower and more variable DM% due to weather conditions and were a major reason the dairy converted to sand lanes and bedding in mid 2007. The composted solids DM% also reflects the DM of materials being applied to stalls. DM % in deep bedded stalls (Fig. 2) ranged from 40 (right after bedding application) to 81%, with DM% 60-75% within 12 hrs. of application. Similar results were seen with solids bedded over mattresses.

Log CFU bacteria counts / gram of composted separated solids material are shown in Figure 3. Total gram negatives, coliforms, and alpha streps ranged from <10^2-10^6, <10^2 or non-detectable, and 10^{4-6}, respectively. Composting resulted in significant decreases in coliform CFU (non-detectable).

Log CFU of composted manure solids being applied into stalls is shown in Figure 4. CFU numbers parallel composted solid CFU (Fig. 3) but are elevated slightly at times (coliforms 10^{2-4}) depending on storage length / site.

Log CFU bacteria counts in separated manure solids in deep bedded compost freestalls (Fig. 5) shows bacteria counts of all groups at ~ 10^{5-6} (some variation) but showing bacteria counts are elevated and plateau in stalls relatively quickly following bedding application and management. Gram negatives and alpha streps elevate slightly compared to initial bedding but coliform numbers increase 10^{2-3}. Similar results were shown in solids bedded on mattresses.

Cow cleanliness, feet and leg health, and cow comfort improved with the bedded solids. Somatic cell counts for 3 years (DHIA) are shown in Fig. 6. This herd had seasonal increased SCC (summers). Herd SCC decreased following separated solids use, although some of this was a seasonal trend. No increases in clinical mastitis were seen except during week of May 29 (see milk bacteria section) and once in July, associated with a feeding problem.

Overall, separated solids showed increased DM (60-80%) once put in stalls (wind or tilling) but bacteria counts elevated and plateaued ~10^{5-7}. However, animals showed excellent stall comfort, cleanliness, and feet and leg health, with SCC stable or decreasing and no association with clinical mastitis. Clinical mastitis outbreaks were associated with milking time and feeding issues. Although bedding bacteria counts are important to manage, proper stall, alley, and milking management are also critical to reduce organism pressures and risks, as well as proper nutrition and housing to maximize animal immunity. The dairy discontinued use of separated solids in 2007 primarily due to lack of adequate separated solids supplies (lower efficiency of screen separators) as well as variability in Iowa weather and product quality associated with outdoor composting and storage.

Table 1. Dairy Bulk Tank Milk Cultures 2006

Date	Str. ag	S. aureus	Coli	G- (oth)	E strep	CNS	Coryn	Bacil	Total
3/22	0	70	50	10	40	500	0	0	500
4/12	0	60	0	0	4500	0	0	0	4500
4/25	0	500	0	0	80	60	0	60	500
5/1	0	20	60	0	200	700	0	0	1000
5/22	0	0	575	10	80	0	360	0	1310
5/29	0	0	13900	0	1500	0	0	0	19000
6/5	0	210	50	0	1000	480	0	0	1000
6/12	0	500	835	10	405	200	0	0	1500
6/20	0	0	85	0	200	360	0	0	720
6/28	0	430	0	0	950	0	0	0	1500
7/3	0	280	60	0	0	0	0	140	400
7/9	0	0	120	10	1280	0	0	0	2000
7/17	0	0	615	0	240	160	0	0	1280

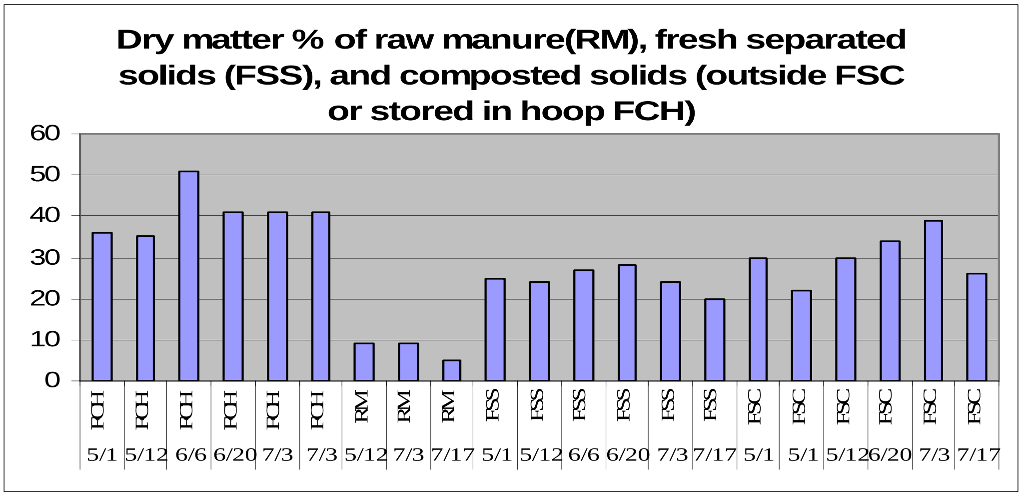

Figure 1. Dry matter content of raw manure (RM), fresh separated solids (screen separator - FSS), and manure solids following composting and stored outside (FSC) or stored in a hoop building (FCH).

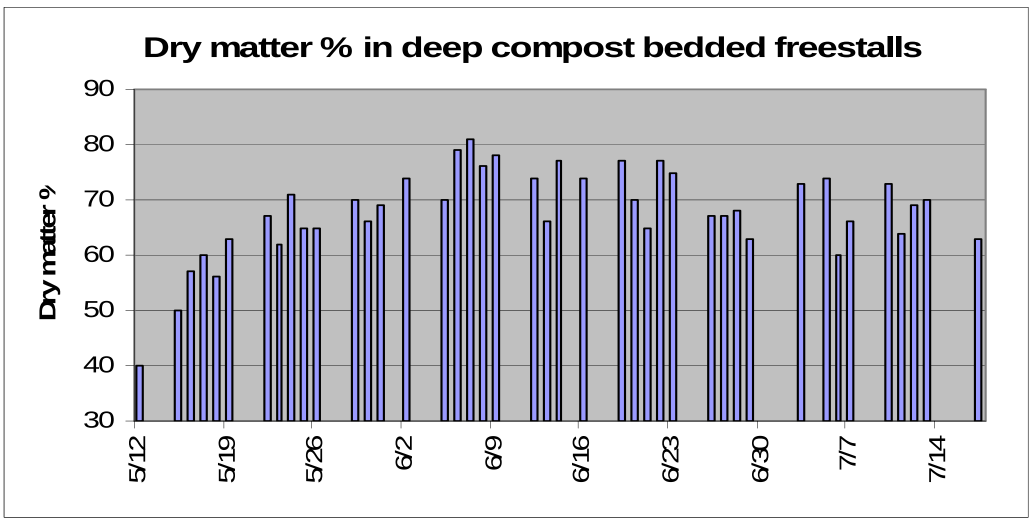

Figure 2. Dry matter content of separated manure solids in deep composted bedded freestalls.

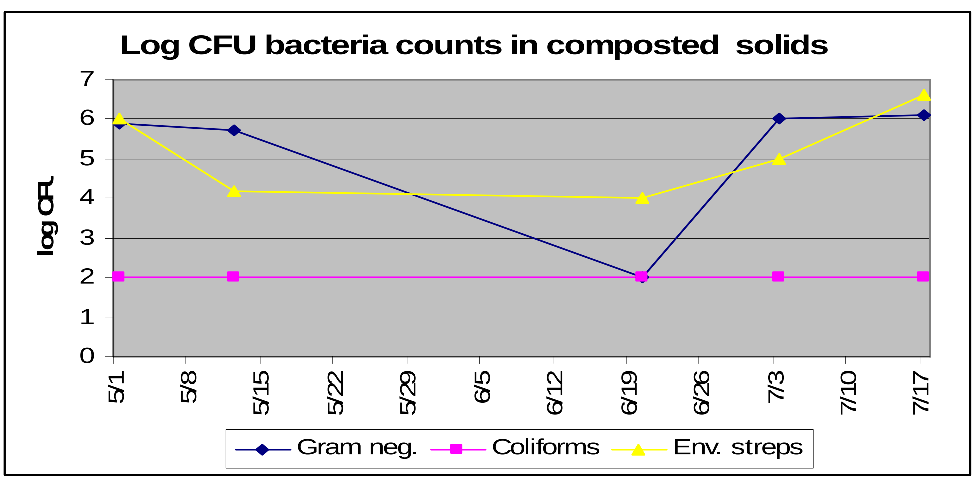

Figure 3. Log CFU bacteria counts in separated manure solids following outdoor composting.

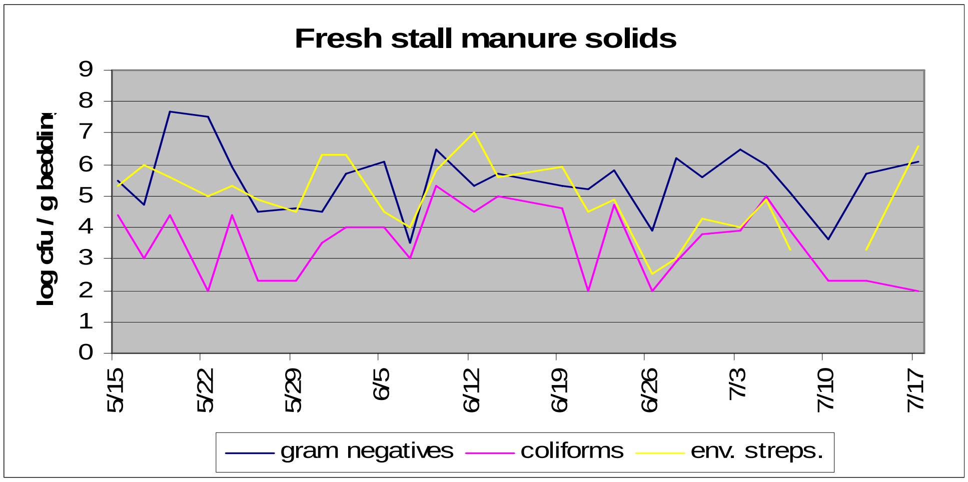

Figure 4. Log CFU bacteria counts in separated manure solids being put into freestall barns.

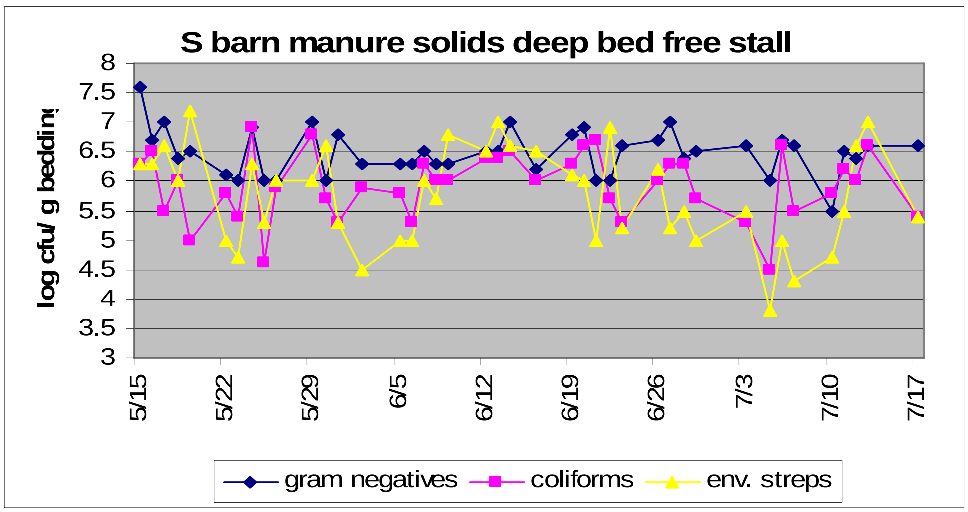

Figure 5. Log CFU bacteria counts in separated manure solids in deep bedded compost freestalls.

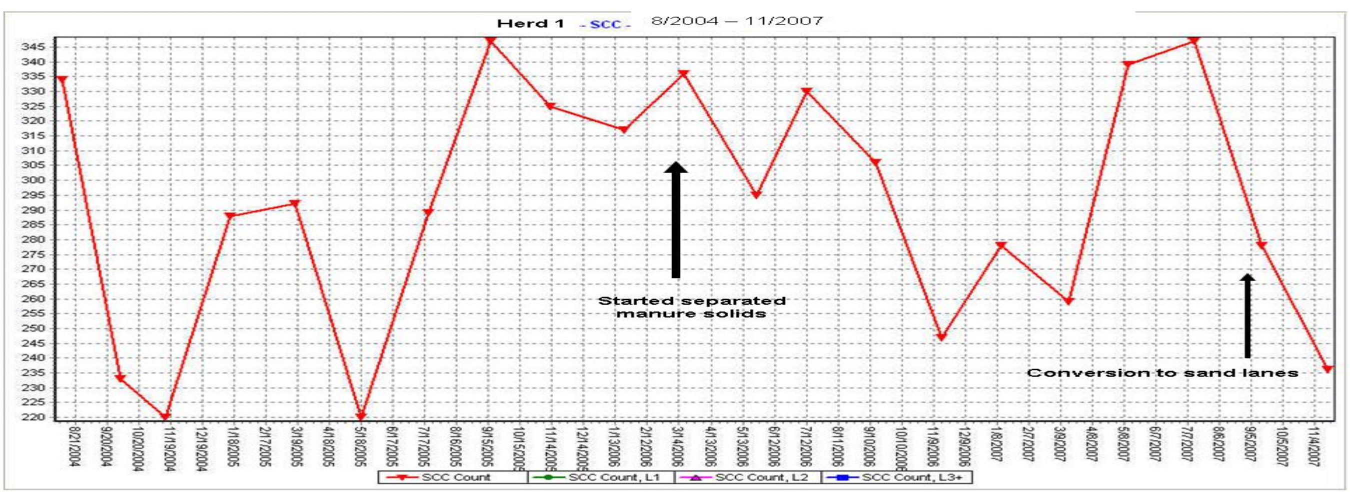

Figure 6. Somatic cell counts in a dairy herd over a 3 year period where separated manure solids were used.